

THREE MILE ISLAND HEALTH RESEARCH PROGRAM: AN OVERVIEW*

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*Paper to be presented at a Special Session on TMI of the American Public Health Association annual meeting, November 16, 1988, Boston, MA.


PHE 68.2 T531n c.2
Tokuhata, George Kazunari,
1925-
Three Mile Island nuclear
accident and health studies

THREE MILE ISLAND HEALTH RESEARCH PROGRAM: AN OVERVIEW

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Immediately following the 1979 nuclear accident at Three Mile Island (TMI), the Pennsylvania Department of Health developed a comprehensive research program to assess potential health effects of the accident upon local populations. During the early period of the crisis, accurate information was not available regarding radioactive emissions from the damaged nuclear reactor into the environment; however, the presence of diffuse and growing psychological disturbance in the area was apparent. Many of the studies conceived during this period reflected the existing epidemiologic knowledge regarding biological effects of ionizing radiation¹ and/or psycho-social consequences of disaster² in both short-term and long-range contexts. Because of limited in-house resources, certain studies were carried out jointly with university scientists. A special Scientific Advisory Panel was commissioned to oversee the development and technical guidance for the TMI Health Research Program. The purpose of my presentation is to give an overview of this Program after which some of the specific studies will be presented by collaborating authors.

- A. TMI Census: One of the first projects initiated was a special census of all persons residing within five miles of TMI.³ The primary purpose of TMI census was to develop a population profile which would provide a basic framework for future studies of morbidity and mortality. In



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addition to usual demographic data, the census questionnaire included marital status, smoking habits, medical history including cancer and thyroid diseases, pregnancy experience, medical-occupational radiation exposure, and detailed whereabouts during the 10-day crisis when abnormal radioactive releases were reported. During the census-taking 35,946 individuals were enumerated for which technical guidance was provided by the U.S. Bureau of the Census and the Centers for Disease Control.

B. Evacuation: No mandatory total population evacuation was ordered during the crisis. However, following the Governor's advisory to evacuate pregnant women and small children, some 64% of local population within a 5-mile radius of the TMI facility did evacuate.¹⁷ Those who evacuated, as compared with those who did not, tended to be younger, females, more educated, white collar workers, and living closer to the damaged nuclear reactor. As opposed to what might be expected, many medical personnel working at various health care facilities in the area evacuated just as any other population groups. Detailed evacuation data collected on all individuals within a 5-mile radius and all pregnant women within a 10-mile radius provided essential data for proper calculation of radiation exposure.

C. Radiation Dose Assessment: One of the most important tasks in the TMI Health Studies Program was to estimate the extent to which local residents were exposed to radiation from the damaged nuclear reactor. This study was conducted by the Department of Radiation Health of the University of Pittsburgh with population and evacuation data provided by the Pennsylvania Department of Health.¹² Based on the detailed

evacuation data along with documented and calculated radiation doses from TLD and other available readings and meteorological information, individualized "maximum possible" and "most likely" wholebody gamma, total skin, and thyroid tissue doses were derived for those who were residing within a 5-mile radius and those pregnant women and fetuses who were residing within a 10-mile radius of TMI. The study indicated that the maximum wholebody gamma dose to anyone off site within a 5-mile radius was no greater than 165 mrem (average 24 mrem) and 80 mrem (average 10 mrem) when evacuation was taken into account. Within a 10-mile radius, the average wholebody gamma dose to the pregnant women and fetuses was estimated to be 10 mrem; this estimate was reduced to 4 mrem when evacuation was taken into account. These radiation dose estimates were related to some of the health studies completed and will continue to be used in future studies when indicated. While no major physical effects are expected from these low doses, these estimates have been challenged by some scientists and local residents as being too low.

- D. Behavioral and Psychological Studies: One of the major concerns during the crisis was the psycho-behavioral impact of the nuclear accident upon local residents. Several related questions were addressed: (a) What proportion and characteristics of the local population was impacted psychologically? (b) How did local residents cope with the crisis situation? (c) What social and/or medical services were utilized by those who were disturbed? (d) What kind of stress-related symptoms, mental and physical, were reported? (e) Was the psychological impact short-lived or long-lasting? A series of psycho-behavioral studies were

conducted as a joint endeavor between the Department of Behavioral Science at the Hershey Medical Center and the Division of Epidemiology Research of the Pennsylvania Department of Health. These studies¹¹ indicated that persons who were younger, more educated, married and females were more likely to have been distressed. The number of persons with severe distress dropped shortly after the accident, but those who were residing close to TMI remained distressed nine months after the accident. Some of those residing near the plant used more alcohol, tobacco, sleeping pills and tranquilizers during the two-week period of crisis than before, but the use of these substances which was mediated through coping did not persist beyond that time.

- E. Pregnancy Outcome: Both ionizing radiation and psychological stress can affect human reproductive process and pregnancy outcome.⁴⁻⁷ For this reason, an evaluation of pregnancy outcome (up to neonatal period) in the TMI area was considered to be a high priority endeavor. The study group (cohort) included all pregnant women who delivered within a 10-mile radius from March 28, 1979 through March 27, 1980. This group of 3,946 deliveries was compared with a control group (cohort) of 4,046 deliveries during a one-year period immediately following the study group in the same geographic area. Outcome measures investigated were: fetal deaths (16+ week gestation); neonatal deaths (within 27 days); prematurity (gestation < 37 weeks); immaturity (birthweight < 2,500 grams); congenital anomalies; and low Apgar scores (less than 7 at one minute). The extent of psychological stress was estimated by overt statements of psychological "disturbance" ("extremely", "somewhat", or "not" disturbed)

as reported by individual women in the study. The level of radiation exposure was estimated individually in terms of wholebody gamma, total skin (gamma plus beta), and thyroid tissue (gamma) doses with and without evacuation taken into account. A number of confounding variables were considered including both maternal and provider characteristics as well as birth order and medical procedures used while pregnant.

Except for an increased risk of low birthweight associated with extra medications taken by stressed women while pregnant, no significant abnormalities were found in any of the outcome measures evaluated.⁸

F. Spontaneous Abortions: Because of the known sensitivity of the fetus to ionizing radiation, a study of spontaneous abortions was carried out to determine if there was evidence of an increase in fetal losses prior to 16-week gestation.¹³ The population census conducted within a 5-mile radius shortly after the accident contained the data on pregnant women which provided the necessary baseline data; this and additional one-year follow-up data made this study possible. The results published by the American J. of Public Health ¹³ indicated that the rate of spontaneous abortions among pregnant women around TMI was 0.15, which was comparable to those of other reported studies.

G. Congenital Hypothyroidism: A small amount of radioactive iodine was released to the environment from the damaged nuclear reactor during the crisis, which could have been taken up by both maternal and fetal thyroid glands through placenta. The fetal thyroid glands are more sensitive to radioactive iodine than are the mother's thyroid glands; therefore, a

small dose to the mother can be a larger dose to the fetus. For this reason, the incidence of hypothyroidism among newborns was investigated.⁹

During the March 28, 1979 - March 27, 1980 period, one case of congenital hypothyroidism was identified among 3,967 infants within a 10-mile radius; this was within a normal range of the expected incidence. Also noted was the lack of cases reported within eight county areas down-wind from the TMI facility during the March 28, 1979 through December 31, 1979 period. An apparent clustering of seven cases reported in Lancaster County during 1979 was subjected to an in-depth evaluation because of the physical proximity and timing related to the TMI accident. One of the cases was reported prior to the accident. Except for two cases for which radiological tests were refused by parents, the remaining four cases were explainable in terms of late gestation at exposure, dysgenesis, or dysmorphogenesis.

Apart from the incidence analysis, human thyroid dose of radioactive iodine monitored in the vicinity of the TMI facility was estimated to be 7.5 mrad.¹⁰ At least 1,000 times greater thyroid doses would be required to begin to have significant acute damages to the thyroid glands.⁴⁻⁵ From the experiences of the Marshallese exposed to fresh radioactive fallout, as much as 50 to 100 rads would be necessary to cause irreversible tissue damages, such as hypothyroidism or thyroid cancer.⁴⁻⁵

H. Fetal and Infant Mortalities: In-utero exposure to ionizing radiation has been associated with fetal and infant mortalities.¹⁴⁻¹⁵ To determine if the 1979 nuclear accident at TMI affected the level of mortality among fetuses and/or children under one year of age, a study was conducted of fetal, neonatal and infant deaths within a 10-mile radius of TMI.¹⁶ The analyses included both cross-sectional and longitudinal comparisons of the observed and expected numbers. No significant differences were noted between the TMI area and Pennsylvania as a whole, nor was there evidence of significant differences between pre-accident and post-accident years. In addition, the temporal pattern of quarterly (3-month interval) infant mortality immediately following the accident was evaluated to determine if the pattern was significantly different from normal expectation as a possible indication of differential effects upon the fetus of exposure to radiation at different gestation periods. The result of this analysis showed no such evidence.

I. Long Term Follow-up Studies: The aim of the TMI Health Studies Program is to provide information derived from sound epidemiologic studies regarding possible health effects of the TMI nuclear accident upon local residents. Based on the generally accepted radiation exposure data and from the reported epidemiologic studies of low dose radiation elsewhere, major adverse health effects of the TMI accident are not expected. However, this assurance is only as good as the radiation data itself, which has been a subject of controversy. At the same time, the potential long-term effect of psychological stress needs to be evaluated

independently of radiation. The already established TMI Population Registry and the TMI Mother-Child Registry will provide reliable data bases for long-term follow-up studies of health status of the general population and the special cohort of pregnant women including their in-utero exposed children. Causes of death and cancer diagnoses are routinely ascertained by linkage to the state and national mortality files and the Pennsylvania Cancer Registry. Data on other physical, psychological and behavioral health indices are collected through periodic morbidity surveys, including child growth and development, based on random samples from the two original TMI cohorts. Two selected follow-up studies will be presented today; they are: Women Pregnant During the TMI Crises -- Mothers' Perceptions of Health, Five Years Later; TMI Population Registry-Based Cohort Mortality 1979-1985.

- J. Cancer Mortality and Morbidity: In 1985 we conducted a cancer mortality and morbidity study in the vicinity of TMI.¹⁸ Cross-sectional population up to a 20-mile radius was compared with Pennsylvania as a whole while observed and expected numbers of cancer deaths were compared for each of the before- and after-TMI periods. We found no evidence that cancer mortality in the vicinity of TMI was significantly different from expectation. In addition, a more detailed analysis was made of the data for four selected communities down-wind (NW) from the TMI facility. No significant abnormalities were noted either in cancer mortality or incidence among residents of these selected communities considered to be of potential higher risk. Particularly noted were less than expected

numbers of leukemia (deaths as well as new cases), the only form of cancer associated with ionizing radiation that could have manifested itself within a short time period after exposure.

K. Epidemiologic Surveillance Around Nuclear Power Plants in Pennsylvania:

As a result of the 1979 nuclear accident at TMI, a unique program of epidemiologic surveillance around nuclear power plants was developed in Pennsylvania. This is basically a screening program designed to signal potentially significant deviations in the general health status of the cross-sectional population in each of the five geographic locations. Minimum data set including routinely available natality and mortality statistics are used. A maximum of 20-mile radius of each plant site is covered in order to be consistent with the PA Emergency Management Agency's requirement for evacuation plan. Smaller geographic areas are also considered separately as needed. Selected health data are compared both longitudinally and cross-sectionally with normative standards. If and when significant differences or changes are observed, an in-depth epidemiologic study will be conducted to determine its cause(s). This project is still in its developmental stage which requires a series of testings of the methodology and data suitability and availability.

Epilogue: Regardless of the results of a variety of studies undertaken, there is scientific need to document the potential health effects of low dose radiation and/or substantial psychological stress in humans. The TMI nuclear accident, the most unique experience in the U.S. history, created a rare opportunity to respond to the much publicized, important public health concerns.

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